A visual, interactive introduction to basic and advanced magnetic resonance techniques

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A VISUAL, INTERACTIVE INTRODUCTION TO BASIC AND ADVANCED MAGNETIC RESONANCE TECHNIQUES

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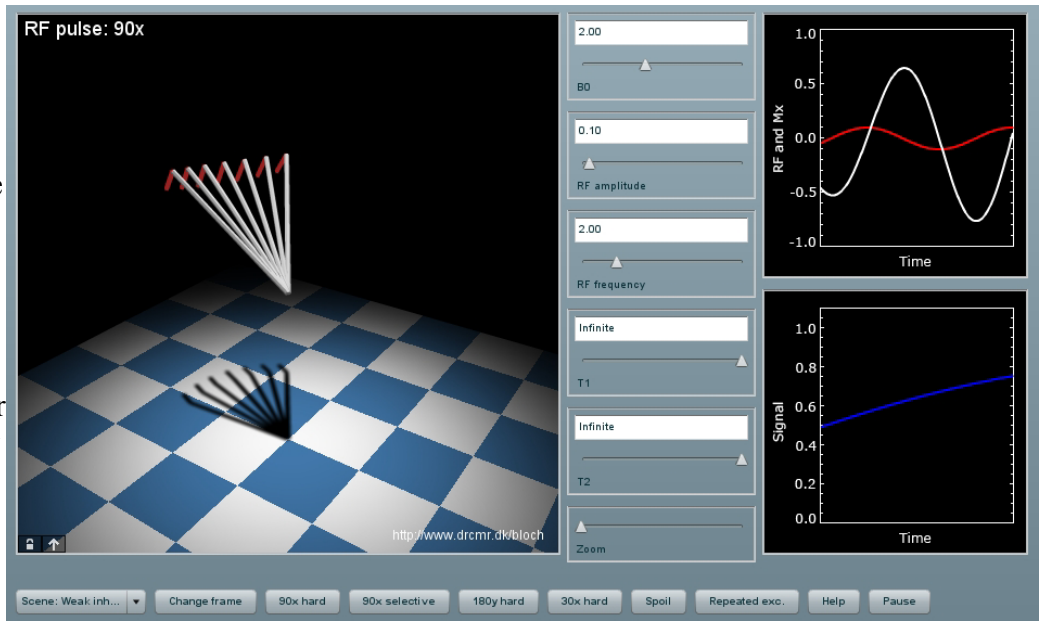
The presentation is aimed at persons who are already familiar with the "ingredients" of MRI, but do not feel that they fully understand basic MRI techniques, and who lack the mental pictures that would normally only come after having studied NMR and MRI basics intensively. The presentation does not give an instant, deep understanding, but it introduces an educational tool of general relevance and a few important phenomena in a visual, interactive way. The presentation is aimed at inspiring additional experimentation which may pave the way for a solid understanding of concepts such as excitation, dephasing, relaxation, sequences, echo formation and k-space imaging. To exemplify this approach, the basic NMR phenomenon and the idea of one-dimensional k-space imaging is introduced. The first is an example of a basic, but intellectually challenging technique, whereas the latter is typically considered advanced and very abstract.

Background: It is central for the understanding of all NMR and MRI techniques to know the effects of varying magnetic fields and relaxation on the sample magnetization. This need is common to most people working with magnetic resonance including radiographers, radiologists, chemists and physicists. The Bloch equations [1] and their solutions hold the key to a real understanding of MRI but they are unfortunately not easily accessible. Bloch equation solutions can be visualized and understood intuitively, however. Graphical software that can be executed directly in any web browser has been developed for this purpose [2]. It can advantageously be used by lecturers in classes and by students for exercises. The unique software allows for interactive experimentation with spatially and temporally varying fields used for manipulating the magnetization of a nuclear sample, thus helping students to gain a deep understanding of NMR and MRI techniques.

Presentation technique: The presentation is based on interactive use of the Bloch Simulator[2]. An earlier implementation of the software is described in reference [3]. It is now available in a new implementation programmed in ActionScript®. It that can therefore be embedded in PowerPoint® presentations, for example, or be executed in any browser. More than 95% of all PCs have a Flash Player® installed [4], and can therefore run the simulator immediately. The figure shows how visualization of excitation in the presence of weak inhomogeneity can be visualized. The white bars are magnetization vectors of isochromates precessing at different frequencies. The red bars indicate the instant "push" (torque) by radio waves, on these.



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